CH_4 concentrations during the Holocene reconstructed from the NEEM (Greenland) and Dome Fuji (East Antarctica) ice cores

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Methane (CH_4), the second most important anthropogenic greenhouse gas, has increased in the atmosphere by a factor 2.5 since the onset of the Industrial Revolution, which account for ~20% of the total increase in radiative forcing over that time[1]. Ice cores from both polar regions preserve the past atmospheric CH_4, and thus have the potential to constrain the changes in CH_4 concentration difference between the polar regions. The inter polar difference of CH_4 is one of the approaches to understand the evolution of CH_4 budget and its relationship with climate. To reconstruct the CH_4 inter polar difference during the Holocene, we have been measuring CH_4 concentrations in the NEEM (Greenland) and Dome Fuji (Antarctica) ice cores over the period from 200 to 14500 years before present (yr BP), with a mean time resolution of ~50 years. Since most of this time period is overlapping with the brittle zone in the Greenland core, it is challenging to reconstruct accurate CH_4 concentration during the Holocene from the NEEM ice core.
Ice samples without visible cracks were carefully selected from the NEEM and Dome Fuji ice cores. We employed a newly established wet extraction system (an improved version of ref. 2) the National Institute of Polar Research, with a typical sample size of ~80 g (ice). The air released from ice was first collected into a sample tube (electropolished stainless steel tube with a metal-seal valve), and then it was split into two aliquots. One aliquot was measured by a gas chromatograph (Agilent Technologies 7890A) for CO_2, CH_4 and N_2O concentrations, and the other was measured by a mass spectrometer (Thermo DELTA V Plus) for $\delta^{15}N$ of N_2, $\delta^{18}O$ of O_2, $\delta(O_2/N_2)$, $\delta(Ar/N_2)$ and total air content. We have measured 181 samples for the NEEM ice core. Analytical precision of CH_4 concentration was estimated to be ±2.4 ppb from the pooled standard deviation from duplicate measurements (n=53).
Before the Holocene, the NEEM CH_4 concentration is relatively high (620-705 ppb) during the Bø lling-Allerød, and it rapidly decreases to <500 ppb during the Younger Dryas, and then increases to ~750 ppb at the beginning of the Holocene. During the Holocene, CH_4 concentration first decreases to the minimum of ~610 ppb around 5000 yr BP, and it increases afterwards. Our record agrees well with a high resolution CH_4 concentration record from the GISP2 ice core for last 2000 years[3], and that of the NEEM ice core measured by a CFA system between 9500 and 14500 yr BP[4].
We completed the NEEM measurements and started the Dome Fuji measurements, and the resulting CH4 inter polar difference will be deduced and discussed in the presentation.
References
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Keywords: Ice core, methane, Holocene, Greenland, Antarctica

